

PRELIMINARY AMENDMENT

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Filing Date: May 24, 2000

Title: HIGH POWER ULTRASONIC TRANSDUCERS

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33. (Amended) The ultrasonic transducer of claim 32 wherein the master wave-guide is a composite master wave-guide [is] comprised of a mode stabilizer and an output amplifier, further wherein the mode stabilizer is made from a material having a speed of sound in excess of 6000 meters per second.

34. (Amended) The ultrasonic transducer of claim [32] 33 wherein the ultrasonic transducer is capable of receiving up to 30 kW of power and outputting frequency in excess of 18 kHz on a continuous basis.

35. (Amended) The ultrasonic transducer of claim [32] 33 wherein the mode stabilizer and output amplifier each comprise a single one-half wavelength [master] wave-guide, further wherein the transducer can produce [produces] a one-full wavelength standing wave in one complete cycle.

36. (Amended) The ultrasonic transducer of claim 35 wherein each active element is a one-half wavelength drive rod [and the] made from a smart [material is a magnetostrictive] material.

37. (Amended) The ultrasonic transducer of claim 36 wherein the smart material is [TERFENOL or TERFENOL-D] selected from the group consisting of piezoelectrics, ferroelectrics, piezoceramics and magnetostrictive materials.

39. (Amended) The ultrasonic transducer of claim [38] 32 wherein the [phase change cooling medium exits the transducer as a fluid-vapor mixture, further wherein the mixture is reliquified in the] refrigeration system comprises a single loop cooling system or a double loop cooling system [for use again in the transducer].

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41. (Amended) The ultrasonic transducer of claim 32 further comprising:
a drive coil surrounding the plurality of sub-motors to provide an electromagnetic field;
and
a magnetic circuit surrounding the drive coil [for biasing], the magnetic circuit designed to bias the active [element] elements.
43. (Amended) The ultrasonic transducer of claim 41 wherein the magnetic circuit comprises:
each active element;
flux concentrators surrounding each active element;
two magnetic rings[,] surrounding all active elements; and
a plurality of cylindrical magnetic pieces located between the two magnetic rings[, the flux concentrators, and each drive rod, further] wherein the magnetic circuit is activated [by providing] when a dc current is provided.
44. (Amended) The ultrasonic transducer of claim 43 wherein [the] each active element [in each sub-motor] is [split lengthwise to form] comprised of a split active element having two sections.
45. (Amended) The ultrasonic transducer of claim 44 wherein each sub-motor further comprises:
a mode containment disk located between the two sections of the split active element, the mode containment disk designed to increase cooling of the split active element;
[a prestress bolt having an opening through which coolant gas exits the sub-motor, the prestress bolt located proximate to the split active element;]
a sub-motor wave-guide contiguous with the prestress bolt;
a gap located between the split active element and the prestress bolt, [wherein a ceramic powder is placed into] the gap [to cool the split active element] designed to hold ceramic powder;
one or more sub-motor flux concentrators[, each] located next to the split active element;
a preload disk located adjacent to one of the one or more sub-motor flux concentrators;

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and

a preload nut located adjacent to the preload disk.

46. (Amended) The ultrasonic transducer of claim 45 wherein the preload nut, one flux concentrator and the preload disk comprise a reaction mass against which the split active element can push [pushes].

50. (Amended) The ultrasonic transducer of claim [45] 39 wherein the [cooling system is a] single loop cooling system comprises:

a heat load source designed to heat the phase change cooling medium, wherein the phase change cooling medium is converted from a fluid-vapor mixture to a superheated vapor;

a compressor located downstream from the heat load source, the compressor designed to keep the superheated vapor under pressure;

a condenser located adjacent to the compressor, the condenser designed to allow the superheated vapor to release heat to produce a sub-cooled fluid; and

an expansion device designed to throttle the sub-cooled fluid prior to entering the transducer.

51. (Amended) The ultrasonic transducer of claim 45 wherein the [master] wave-guide has a tip, further wherein [displacement of] the [master] wave-guide tip [is] can be displaced about 60 micrometers or more peak-to-peak.

52. (Amended) The ultrasonic transducer of claim 45 wherein the transducer [is] can be used in sonochemical processes.

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53. (Amended) A method for channeling ultrasonic energy to perform work comprising:
providing a transducer having a plurality of sub-motors, each sub-motor containing a prestress bolt located proximate to an active element [made from a smart material, wherein the sub-motors operate simultaneously to produce ultrasonic energy];
[cooling] operating the sub-motors [with] simultaneously;
flowing a phase change [fluid that flows] cooling medium through [a cooling system prior to entering] the transducer and [after exiting] through a refrigeration system connected to the transducer; and
[connecting] placing a master wave-guide in a direct load path of the plurality of sub-motors [to a composite master wave-guide], wherein the master wave-guide is reactive to [the] ultrasonic energy provided by the plurality of sub-motors.
54. (Amended) The method of claim 53 further comprising activating the transducer by providing power to a magnetic circuit surrounding the sub-motors, wherein the ultrasonic energy from the sub-motors is channeled to produce work on a continuous basis.
57. (Amended) The method of claim [53] 55 wherein the electromagnetic field is provided by a coil made from a conductive material, the coil concentrically disposed about the plurality of sub-motors.
58. (Amended) The method of claim 57 further comprising providing a dc current to bias the active element [elements].
60. (Amended) The method of claim 53 wherein [the] each active element is a one-half wavelength drive rod [and the] made from a smart material [is a magnetostrictive material].
61. (Amended) The method [ultrasonic transducer] of claim 60 wherein the smart material is [TERFENOL or TERFENOL-D] selected from the group consisting of piezoelectrics, ferroelectrics, piezoceramics and magnetostrictive materials.

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62. (Amended) The method of claim 53 wherein the master wave-guide is a composite master wave-guide comprised of a mode stabilizer and an output amplifier, further wherein the mode stabilizer is made from a material having a speed of sound in excess of 6000 meters per second.

63. (Amended) The method of claim 53 further comprising:
splitting the active element into two sections to form a [split active element] 1/2 wavelength drive rod;

guiding magnetic field intensity through the split active element with one or more flux concentrators;

cooling an inner diameter of each split active element with a silicon nitride or alumina disk; and

adding ceramic powder to a gap between the prestress bolt and the split active element to increase cooling of the split active element.

64. (Amended) The method of claim 63 wherein power generating capability of [the] each drive rod [material] is enhanced by about four times with the one or more flux concentrators.

65. (Amended) The method of claim 63 further comprising:
allowing the flowing [a liquid coolant into the transducer; allowing the liquid coolant to hit] phase change cooling medium to contact a seal plate located in the transducer and splatter radially into [openings in each sub-motor] prestress bolt intake openings, wherein the cooling medium is a fluid prior to contacting the seal plate and a fluid-vapor mixture after contacting the seal plate; [and]

venting [a] the fluid-vapor mixture through an exhaust port in the transducer, the mixture first exiting each prestress bolt through [an opening in the] prestress bolt [of each sub-motor] outlet openings; and

in the refrigeration system, heating the fluid-vapor mixture prior to flowing it through a compressor to produce a superheated vapor.

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Please add the following new claims:

66. (New) The ultrasonic transducer of claim 37 wherein the magnetostrictive material is TERFENOL or TERFENOL-D.
67. (New) The ultrasonic transducer of claim 66 wherein the TERFENOL or TERFENOL-D is laminated.
68. (New) The ultrasonic transducer of claim 50 wherein the double loop cooling system further comprises a heat exchanger through which the cooling medium can flow to transfer heat.
69. (New) The ultrasonic transducer of claim 50 wherein the heat load source is variable or constant.
70. (New) The ultrasonic transducer of claim 69 wherein the expansion device is an expansion valve or a thermal expansion valve.
71. (New) The ultrasonic transducer of claim 40 wherein the phase change medium is a refrigerant selected from the group consisting of R-134a, R-123a, R-124, R-22/152a/124, R600, R600a, HC-601, HC-601a, R-717, R-744, RC270, PFC-C318, R-E134, dimethyl ether and R-E245fa1.
72. (New) The ultrasonic transducer of claim 50 wherein each prestress bolt has prestress bolt inlet openings through which a cooling medium fluid can enter and prestress bolt outlet openings through which a cooling medium fluid-vapor mixture can exit.
73. (New) The ultrasonic transducer of claim 1 wherein the refrigeration system is a chiller system.

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74. (New) The method of claim 60 wherein the magnetostrictive material is TERFENOL or TERFENOL-D.

REMARKS

Claims 32-37, 39, 41-46, 50-54 and 57-65 have been amended and claims 66-74 have been added. The amendments to the claims and the new claims have support throughout the specification. The amendments to the claims and the new claims are intended to clarify Applicant's invention and not intended to limit the equivalents to which any claim element may be entitled. No new matter has been introduced as a result.

The pending claims are 1-74. The Examiner is invited to contact Applicant's attorney at the below telephone number if prosecution can be assisted thereby.

Respectfully submitted,

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I hereby certify that this paper is being transmitted by facsimile to the U.S. Patent and Trademark Office on the date shown below.

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